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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/039,277	01/04/2002	Frank D. Husson JR.	SOLAR1120-3	1245

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EXAMINER	
PRICE, CARL D	

ART UNIT	PAPER NUMBER
3749	

DATE MAILED: 05/12/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Interview Summary	Application No.	Applicant(s)	
	10/039,277	HUSSON, FRANK D.	
	Examiner	Art Unit	
	CARL D. PRICE	3749	

All participants (applicant, applicant's representative, PTO personnel):

(1) *CARL D. PRICE*. (3)_____.

(2) *MR. HAY*. (4)_____.

Date of Interview: *09 May 2005*.

Type: a)☒ Telephonic b)☐ Video Conference
c)☐ Personal [copy given to: 1)☐ applicant 2)☐ applicant's representative]

Exhibit shown or demonstration conducted: d)☐ Yes e)☒ No.
If Yes, brief description: _____.

Claim(s) discussed: *NONE*.

Identification of prior art discussed: *See Continuation Sheet*.

Agreement with respect to the claims f)☐ was reached. g)☒ was not reached. h)☐ N/A.

Substance of Interview including description of the general nature of what was agreed to if an agreement was reached, or any other comments: *See Continuation Sheet*.

(A fuller description, if necessary, and a copy of the amendments which the examiner agreed would render the claims allowable, if available, must be attached. Also, where no copy of the amendments that would render the claims allowable is available, a summary thereof must be attached.)

THE FORMAL WRITTEN REPLY TO THE LAST OFFICE ACTION MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW. (See MPEP Section 713.04). If a reply to the last Office action has already been filed, APPLICANT IS GIVEN ONE MONTH FROM THIS INTERVIEW DATE, OR THE MAILING DATE OF THIS INTERVIEW SUMMARY FORM, WHICHEVER IS LATER, TO FILE A STATEMENT OF THE SUBSTANCE OF THE INTERVIEW. See Summary of Record of Interview requirements on reverse side or on attached sheet.

Carl D. Price
Primary Examiner

Examiner Note: You must sign this form unless it is an Attachment to a signed Office action.

Examiner's signature, if required

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)
In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

Continuation of Identification of prior art discussed:

Prior art documents newly discovered by the Examiner: "SODIS Technical Note #17, Sodis Bags and Temperature Sensors (http://www.sodis.ch/files/note17.pdf"), "A SUMMARY OF WATER PASTEURIZATION TEXHNIQUES"(Dale Andreatta, Ph. D. P.E.) (http://solarcooking.org/solarwat.htm); "Recent Advances in Solar Water Pasteurization (http://solarcooking.org/metcalf.htm); EP001106188A1 (WALKER et al). .

Continuation of Substance of Interview including description of the general nature of what was agreed to if an agreement was reached, or any other comments:

Applicant's representative discussed possible responses to the Advisory action, such as filing an RCE, which would ensure consideration of amendments filed after the Final Rejection to the Drawings and claims as well as the Declaration filed by Applicant. Applicant's representative was also informed of prior art documents newly discovered by the Examiner, which discuss the field of endeavor to which applicant's claims are directed. Applicant's representative was informed that copies of these documents would be facsimile transmitted to applicant's representative. While not discussed during the interview, an additional newly discovered prior art reference GB 1 517 449 (07-12-1978), also disclosing and illustrating the level of ordinary skill in the field of endeavor of applicant's claimed invention, will also be facsimile transmitted to applicant's representative. GB 1 517 449 discloses a solar drinking water heater made from heat sealed flexible transparent, reflective and opaque sheets (2, 3, 4), where the "lower sheet 4 should be a 2-ply laminate comprised of a heat insulating base layer...", and a bottom mounted main "inlet and outlet" water opening and cap (7, 9). .

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Fax Cover Sheet

Date: 09 May 2005

To: MR. HAY	**From:** CARL D. PRICE
Application/Control Number: 10/039,277	**Art Unit:** 3749
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Re: 10/039,277	**CC:**

☒ **Urgent** ☐ **For Review** ☐ **For Comment** ☐ **For Reply** ☐ **Per Your Request**

Comments:
See newly discovered prior art documents:

- GB 1 517 449 (07-12-1978) dislosing a solar drinking water heater from heat sealed flexible transparent, reflective and opague sheets (2, 3, 4) (note: "lower sheet 4 should be a 2-ply laminate comprised of a heat insulating base layer...") and a bottom mounted main "inlet and outlet" water opening and cap (7, 9).

- SODIS Technical Note #17, Sodis Bags and Temperature Sensors (http://www.sodis.ch/files/note17.pdf).

- A SUMMARY OF WATER PASTEURIZATION TEXHNIQUES; Dale Andreatta, Ph. D. P.E. (http://solarcooking.org/solarwat.htm).

- Recent Advances in Solar Water Pasteurization (http://solarcooking.org/metcalf.htm).

- EP001106188A1 (WALKER et al); 06-13-2001; See the discussion of prior art docu,emts in Background of the Invention (column 1 through column 2, line 21).

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(54) Plastic containers for solar disinfection of water

(57) A container is provided for the disinfection of drinking water. The container comprises a body having a first and a second side and defining an interior for receiving a fluid. The first side being defined, at least in part, by a UV transparent layer. The second side is defined, at least in part, by a second layer that either reflects sunlight or generates heat in response to solar energy.

EP 1 106 188 A1

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates generally to methods and devices for disinfecting drinking water.

[0002] There are a number of diarrheal diseases that result from drinking or using contaminated water. These diseases are major contributors to morbidity and mortality in developing countries. It is estimated that as many as six million deaths per year can be attributed to such diseases. Thielman, N.M. and R.L. Geurrant, *"From Rwanda to Wisconsin: The Global Relevance of Diarrhoeal Diseases"*, The Journal of Microbiology; 44: 155-156 (1996).

[0003] In the last two decades, a significant amount of research has focused on the development of systems for decontaminating water in developing countries. Because sunlight is considered the single most important contributor to bacterial die-off in natural water supplies, and is freely available, many efforts have focused on utilizing this resource for disinfecting water supplies.

[0004] Solar radiation is not evenly distributed throughout the world. Moreover, it is depleted and attenuated by the atmosphere. Only a fraction of UV-B (280-320 nm) and UV-A (320-400 nm) radiation, approximately 4% reaches ground level. The most favorable belt for UV exposure is the northern hemisphere (15-35°). This area encompasses many developing nations located in northern Africa and the southern parts of Asia.

[0005] Solar box cookers (SBCs) have been designed for use in resource-poor areas. These devices simply harness the heating capacity of sunlight to raise the temperature of water to 65°C typically for a minimum of one hour. Usually, the heat that is generated is sufficient to pasteurize naturally contaminated water. Ciochetti, D. A., and R.H. Metcalf, *"Pasteurization of Naturally Contaminated Water With Solar Energy"*, Applied Environmental Microbiology, 47:223-228 (1984). Such a system was deployed in Zambia following an outbreak of cholera, and reduced the bacterial load by 10^4 CFU/ml water at 65°C, and effectively sterilized the water at 80°C, although the capacity was reduced at the higher temperature. Jorgensen, A.J. and F.K. Nohr, *"Cholera: Water Pasteurization Using Solar Energy"*, Trop Doctor, 25: 175 (1995).

[0006] Studies have been conducted in which either polyethylene bags (placed on a black or steel surface) or PET soft drink bottles (clear or partially blackened) were filled with river or pond water, inoculated with fecal coliforms and *Vibrio cholerae,* and placed in the sun. Bacterial viability was reduced by 3.0 logs after 140 minutes storage in plastic bags and the effect was dependent upon both heating and UV radiation. Sommer, et al., *"SODIS - An Emerging Water Treatment Process"*, Aqua, 46:127-137, 1997. See also Conroy, R.M., et al., *"Solar Disinfection of Drinking Water and Diarrhoeal in Maasai Children: A Controlled Field Trial"*, Lancet 348: 1695-1697 (1996); Davies, C.M. et al., *"Sunlight and the Survival of Enteric Bacteria in Natural Waters"*, J. Appl. Bacteriol. 70:265-274 (1991); McGuigan, K.G., et al., *"Solar Disinfection of Drinking Water Contained in Transparent Plastic Bottles: Characterizing the Bacterial Inactivation Process"*, J. Appl. Microbiol. 84:1138-1148 (1998); and Reed, R.H., *"Solar Inactivation of Faecal Bacteria in Water: The Critical Role of Oxygen"*, Lett. Appl. Microbiol. 24:276-280 (1997). Additionally, solar heating devices have been used to disinfect water. See Jorgensen, A.J.F. et al., *"Decontamination of Drinking Water by Direct Heating in Solar Panels"*, J. Appl. Microbiol. 85:441-447 (1998).

[0007] Unfortunately, the use of plastic bags or bottles does not provide an optimum system for the disinfection of water in a relatively short time frame. Moreover, solar heating devices that have been employed have the disadvantage that they are complicated and expensive.

[0008] Accordingly, there is a need for an improved, simple method and device for the disinfection of water.

SUMMARY OF THE INVENTION

[0009] The present invention provides methods and devices for disinfecting water. The devices and methods can be used as a primary means for disinfecting water or as adjunct to other means, e.g., boiling water.

[0010] To this end, in an embodiment, a container is provided for the disinfection of drinking water. The container comprises a body having a first and a second side and defining an interior for receiving water. The first side being defined, at least in part, by a UV transparent layer. The second side is defined, at least in part, by a second layer that generates heat in response to solar energy or amplifies the effect of light.

[0011] In an embodiment, the container includes a member for receiving water.

[0012] In a further embodiment, the member is a resealable fitment.

[0013] In a further embodiment, the second layer is constructed from a reflective plastic that amplifies the effect of light.

[0014] In a further embodiment, the second layer is constructed from a metalized reflective plastic.

[0015] In an embodiment, the second layer is constructed from a material that absorbs solar radiation. In a further embodiment, the second layer has a black surface.

[0016] In an embodiment, the second layer is not transparent to UV light.

[0017] In an embodiment, the body is made of a flexible plastic.

[0018] In another embodiment of the present invention, a method of reducing bacteria contaminates in water is provided. The method includes the steps of: providing a container having the body including a first side and a second side the first side is defined, at least in

part, by a UV transparent layer, and the second side is defined, at least in part, by a second layer that generates heat in response to UV light; placing water in the container; and exposing the container to sunlight.

[0019] In an embodiment of the method, the container is exposed to sunlight for at least five hours and preferably for at least eight hours.

[0020] An advantage of the present intention is to provide a device for disinfecting water. Moreover, an advantage of the present invention is to provide an improved method for disinfecting water.

[0021] Further, an advantage of the present invention is to provide a reusable device for disinfecting water.

[0022] Still, an advantage of the present invention is to provide an inexpensive device and method for disinfecting water.

[0023] Furthermore, an advantage of the present invention is to provide a device and method for enhancing the safety of drinking water.

[0024] Additional features and advantages of the present invention are set forth in and will be apparent from the detailed description of the presently preferred embodiment and the figures.

BRIEF DESCRIPTION OF THE FIGURES

[0025] Figure 1 illustrates a perspective view of an embodiment of the container of the present invention.

[0026] Figure 2 illustrates a cross sectional view of the container taken along lines II-II.

[0027] Figure 3 illustrates a cross sectional view of the container taken along lines III-III.

[0028] Figure 4 illustrates a cross sectional view of another embodiment of a portion the container of the present invention.

[0029] Figure 5 illustrates the effect of sunlight on the survival of *Escherichia coli* ATCC 25922 in 250 ml water contained in a plastic pouch (14X17 cm).

[0030] Figure 6 illustrates graphically the effect of sunlight on the survival of *Escherichia coli* ATCC 25922 in 1.0 liter of water contained in a plastic pouch (20 X 28 cm).

[0031] Figure 7 illustrates graphically the effect of sunlight on the survival of *staphylococcus aureus* 485 FDA in 1.0 liter of water contained in a plastic pouch (20 X 28 cm).

[0032] Figure 8 illustrates graphically the effect of sunlight on the survival *of Salmonella choleraesuis* subsp. *choleraesuis* serov. *typhimurium* in water (1 L) contained in a plastic pouch.

[0033] Figure 9 illustrates graphically the effect of sunlight on the survival *of Shigella sonnei* in 1.0 liter of water contained within a plastic pouch (on an overcast day) when the external temperature averaged 10C.

[0034] Figure 10 illustrates graphically the impact of container and beta-carotene on the solar disinfection of water containing *Escherichia coli* ATCC 25922 (reflective plastic pouch).

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

[0035] The present invention provides improved containers and methods for sterilizing water.

[0036] Bacterial disinfection is dependent upon both UV and viable components (400-490 nm) of sunlight, which damage DNA and multiple cellular biomolecules, respectively. The effectiveness of solar disinfection methods and the ability of bacteria to enter into a viable, but nonculturable state, are influenced by salinity and the presence of UV absorbing components like humic acids. The photoinactivation of bacteria is markedly sensitive to aeration rate and sunlight is most effective in fully oxygenated water. Applicants believe that solar disinfection methods rely, at least in part, on the generation of reactive oxygen species and that the disinfection efficiency can be enhanced by the inclusion of the aeration step.

[0037] Applicants have discovered that the effective disinfection of water using solar energy can be achieved by using specifically designed plastic containers (pouch). In a preferred embodiment, the container includes two different faces or surfaces. One of the faces includes a UV transmitting layer. The second face or surface is either a reflective, e.g., metalized, plastic to amplify the light effect, or an absorptive, e.g., black, plastic.

[0038] Referring now to Figure 1, an embodiment of the container 10 of the present invention is illustrated. The container includes a body 12 that, in the preferred embodiment illustrated, is sealed along four sides 14, 16, 18, and 20. Of course, there are a variety of ways to fabricate a plastic container and therefore it is not necessary that the body 12 includes four side seals.

[0039] The body 10 includes a first surface 22 that includes a UV transmitting layer. The UV transmitting layer, as the name implies, provides a structure that allows a majority of ambient sunlight to be transmitted through the surface 22. A number of plastics can be used to construct the first surface 22. For example, the following materials can be used to construct the UV transmitting layer: ethylene vinyl acetate; polypropylene; polyethylene; polyvinyl chloride; polybutylene; polyvinylidene chloride; PET; and blends and combinations thereof. A great variety of plastics can be used. What is required is that the material does not contaminate the fluid contained therein and is substantially transparent to visible and UV light.

[0040] Referring to Figure 2, a cross-sectional view of the first surface 22 is illustrated. As illustrated, a three layer plastic structure 24 defines the first surface 22. The structure 24 includes an inner layer 26, a tie layer 28, and an outer layer 30. In a preferred embodiment, the outer layer 30 is biaxially oriented nylon, the tie layer 28 an adhesive, and the inner layer 26 is linear low density polyethylene. It should be appreciated that although in the preferred embodiment illustrated in Figure 1 at least substantially the entire first surface 22 is UV transmitting

that the first surface can include non UV transmitting portions.

[0041] The first surface 22 is bonded, in the preferred embodiment illustrated in Figure 1, to a second surface 32 that includes a metalized reflective plastic to amplify the light effect. This allows light to pass through the first surface 22, through the container, and to be reflected off the second surface 32 back into and through the interior of the container 10.

[0042] Similar to the UV transmitting layer, a variety of plastics and materials can be used to construct the second surface 32. For example, the following plastics can be used: ethylene vinyl acetate; polypropylene; polyethylene; polyvinyl chloride; polyvinylidene chloride; polybutylene; PET; blends and combinations thereof can be used with a metalized layer.

[0043] Referring to Figure 3, an embodiment of the second layer 32 is illustrated in cross-section. The second layer 32 comprises, in the illustrated embodiment, a five layer structure. This structure includes an outer layer 33, core layer 35, and an inner layer 37. Two tie layers 34 and 36 are also provided. In the preferred embodiment illustrated the outer layer 33 is PET, the core layer 35 metalized PET, and the inner layer linear low density polyethylene 37. The two tie layers 34 and 36 are adhesives.

[0044] In an embodiment of the container, a portion of which is illustrated in Figure 4, the UV transmitting layer is bonded to a second surface 40 that includes an absorptive black plastic. This material will absorb light that passes through the interior and functions to elevate the temperature of the water contained in the container. The second layer can be constructed from a variety of plastics including ethylene vinyl acetate, polypropylene, polyethylene, polyvinyl chloride, polyvinylidene chloride, polybutylene, PET, blends and combinations thereof, with a black or dark ink added thereto. The second layer 40 in the illustrated embodiment, includes a sealant layer 42 (low density polyethylene), tie layer 44 adhesive, and an outer layer 46 PET to which black ink has been added.

[0045] In the preferred embodiment of the container 10 illustrated in Figure 1, the container 10 includes a fitment 48. The fitment 48 allows one to access the interior of the container 10. This allows water to be added to the container 10. Preferably the fitment 48 includes a removable closure 50 that allows an opening, defined by the fitment, to be closed after the container is filled sealing the container.

[0046] It should be noted that, there are a variety of different container structures that can be used in the present invention. Likewise, a variety of different techniques and materials can be used to construct the container.

[0047] By way of example, and not limitation, examples of the present invention will now be given.

EXPERIMENT

[0048] The purpose of this experiment was to evaluate means of disinfecting microbiologically contaminated water through the transmission and amplification of incident solar radiation. Specifically, this experiment was to test the concept of a reusable plastic pouch designed to minimize the light path and assembled of materials selected to transmit and reflect the UV-A and UV-B radiation through a layer of water.

Methodology, Trials, Results

[0049] Plastic pouches were designed to maximize the exposure of artificially contaminated Poland Springs Water to incident solar radiation. The pouches were of such dimensions as to contain 250 or 1000 ml of water at a depth (light path) of no more than 4.0 cm. A plastic film was selected to transmit a significant portion of the incident UV radiation above 250 nm and bonded to either a reflective or absorptive layer. Following the addition of sterile water, the pouches were heat-sealed and a bacterial load added (6.5 log CFU/ml) by injection through a rubber septum.

[0050] The plastic pouches were held in darkness (control samples) or placed in a foil lined cardboard box and exposed to sunlight (experimental samples) or exposed directly on a flat surface. Internal temperatures were monitored and samples were withdrawn periodically for an estimation of viable bacterial load.

[0051] In the first trial, the viable count of *Escherichia coli* was reduced 4.5 logs in 5 hours of exposure. In the first 1.5 hours, the reflective pouch was 3 logs more efficient even though the temperature in the absorptive pouch was 15°C higher.

[0052] In the second trial, *E. coli* viable counts again dropped 6.5 logs in 5 hours. There was no difference in bactericidal activity in the two pouches even though there was a 10°C difference in temperature.

[0053] In the second trial, viable counts *of Staphylococcus aureus* also declined 6.5 logs, and the reflective pouch was slightly more efficient.

[0054] In the third trial, *Salmonella typhimurium* viable counts declined 3.5 logs in the reflective pouch and only 1.0 log in the absorptive pouch. The day length had begun to decline by this experiment.

[0055] In the fourth trial, while *Shigella sonnei* counts declined 4.5 logs in the reflecting pouch, no effect was observed in the absorptive pouch. At the time of this experiment the ambient temperature averaged 10°C and the sky was considerably overcast.

[0056] In the final experiment, *E. coli* viable counts were reduced 7.0 logs in the reflective pouch, regardless of whether the trial was conducted in a reflective box or on the exposed roof surface. The addition of β-carotene, significantly reduced the bactericidal effect on sunlight, either by blocking sunlight or by absorbing oxygen, reducing the production of free radicals.

Conclusion

[0057] Based upon these trials, the concept of a reusable plastic pouch that utilizes and amplifies the UV radiation of sunlight to sanitize water appears to be effective against a range of potential food pathogens including *E. coli, S. aureus, S. typhimurium* and *S. sonnei* when these organisms were inoculated into mineral water.

Materials and Methods

[0058] The initial work involved designing a plastic pouch in which a UV transmitting layer is bonded to one of two surfaces: a) metalized, reflective plastic to amplify the light effect; or b) an absorptive, black plastic to elevate the water temperature. The reflective pouch consisted of two layers: a) a transparent layer of 60 ga biaxially oriented nylon (for strength), adhesive, and 3 mil linear low density polyethylene (for sealing) (see Fig. 2); and b) a reflective layer of 48 ga PET (for strength), adhesive, metalized 48 ga PET, adhesive, and 3 mil linear low density polyethylene (for sealing) (see Fig. 3). The absorptive pouch consisted of an identical transparent layer bonded to an absorbent layer of 48 ga PET/ ink (100% black)/adh/3 mil linear low-density polyethylene (for sealing) (see Fig. 4). The pouch materials were cut to the dimensions 14 X 17cm (250 ml) or 20 X 28cm (1.0 L), sealed on three sides, and filled volumetrically so that the light path did not exceed 4.0 cm.

[0059] The design of the reflective plastic pouch is illustrated in Figure 1. For most experiments the various plastic pouches were shielded from the wind by placing them within a three-sided cardboard box lined with aluminum foil. During the day the boxes were periodically realigned with the sun to maximize exposure to sunlight.

[0060] With the exception of the final set, all experiments involved the placement of the various plastic pouches on the roof of a facility in Connecticut, in a cardboard box that was lined with aluminum foil to increase reflectivity. Each pouch contained 250 ml or 1.0-L sterile water (tap or Poland Spring) which was inoculated (6.5 Log CFU/ml) with an overnight culture of one of the following: *Escherichia coli* ATCC 25922, *Staphylococcus aureus 485* FDA, *Salmonella choleraesuis* subsp. *choleraesuis* serov. *typhimurium,* or *Shigella sonnei.*

[0061] At each sample period, the temperature was recorded by thermocouple and an aliquot of contaminated water withdrawn by syringe; serially diluted and evaluated for viable bacteria on plate count agar (PCA) and/ or Brain Heart Infusion Agar (BHI Agar). Only reflective pouches were used in the final set of experiments in which two were placed in the standard reflective box, one with β-carotene as an antioxidant (Reflective+-(β-carotene) and one without (Reflective), one was placed in a simple cardboard box with no reflective lining (Non-reflective), one was placed flat on the roof surface (unprotected) and one was covered (Control).

Results and Discussion

[0062] In the initial trial using small pouches containing 250 ml volumes, the viable (culturable) colony forming units (CFU) per ml of *E. coli* contaminated water were reduced at least 4.5 logs during 5 hours of exposure to sunlight (see Figure 5). Though the final cell counts were comparable between the reflective and absorptive pouches, the reflective pouch proved 3 logs more efficient in the first hour and a half, even though the temperature in the absorptive pouch was 15°C higher.

[0063] More dramatic declines in *E. coli* viability were observed in the second trial, when a larger pouch volume (1.0 L) was employed. Detectable CFU/ml were reduced by 6.5 logs in 5 hours in pouches bearing reflective and absorptive backing (see Figure 6) which provided an effective sterilization. Even though an increase in temperature was observed with the absorptive pouch (45°C) over that obtained in the reflective pouch (34°C), terminal effectiveness was not improved. During the same trial a similar decrease in *S. aureus* viability was observed (6.5 log in 5 hours) (see Figure 7). Unlike the results obtained with *E. coli,* the viability of the *S. aureus* bacteria added to the reflective pouch declined more rapidly (≥ 1.0 log), indicating a higher level of UV sensitivity.

[0064] Additional studies were conducted with waterborne bacteria that have previously been implicated as etiologic agents in human diarrheal disease. The first of these, *Salmonella choleraesuis* subsp. *typhimurium,* also proved sensitive to solar radiation. In a little over 5 hours, viable CFU/ml declined no more than 1.0 log in the absorptive plastic pouch (35°C Max). The increased effectiveness of the reflective pouch was clearly evident (≥ 3.5 log reduction), though the absolute rate of killing was lower than that observed with *E. coli* and *S. aureus* (see Figure 8). This reduction in effectiveness could have resulted from a decrease in sunlight since the experiment was conducted later in the month of October and the sun was lower on the horizon.

[0065] The second of these experiments, conducted with *Shigella sonnei,* revealed that the reflective plastic pouch continued to be effective against potential diarrheal agents, even with a further decline in available sunlight as evidenced by an average external temperature of 10°C. While viable bacteria contained within the reflective pouch declined 4.5 logs in 6 hours, those in the absorptive pouch were completely stable (see Figure 9). This is a strong indication that doubling the light path by incorporating a reflective backing, as opposed to an increase in temperature through absorption, is a key factor in bacterial inactivation.

[0066] A final set of experiments was conducted to evaluate the critical features of solar disinfection using the reflective plastic pouch. Reflective plastic pouches containing 1.0 liter aliquots of water were inoculated with the target microorganism *E. coli* ATCC 25922 and

exposed to sunlight for at least five hours.

14. A container for reducing bacterial content of water comprising:

a body defining a chamber designed to receive water;
a resealable opening for receiving water;
a first layer that is transparent to at least UV light; and
a second layer that generates heat in response to UV light.

15. The container of Claim 14 wherein the second layer is constructed from a material that absorbs solar radiation.

16. The container of Claim 14 wherein the second layer has a black surface.

17. A container for reducing bacterial content of water comprising:

a body defining a chamber designed to receive water;
a resealable opening for receiving water;
a first layer that is transparent to at least UV light; and
a second layer that reflects UV light that passes through the first layer back into the chamber.

18. The container of Claim 17 wherein the second layer is constructed from a reflective plastic.

19. The container of Claim 17 wherein the second layer is constructed from a metalized reflective plastic.

20. The container of Claim 17 wherein the member is a resealable fitment.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 12 6723

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 4 520 793 A (HALL CHARLES P) 4 June 1985 (1985-06-04) * example * * figures * * claims * ---	1-20	A61L2/04 A61L2/08 A61L2/10 F24J2/34 C02F1/14
X	GB 2 040 436 A (SUNLUST DEV) 28 August 1980 (1980-08-28) * page 1, line 87 - line 116 * * figures 1,2 * * claims * ---	1-8, 10-20	
D,X	WEGELIN M ET AL: "SODIS - an emerging water treatment process" AQUA, vol. 46, no. 3, 1997, pages 127-137, XP000991569 Oxford, UK * the whole document * -----	1-3, 6-17,20	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

F24J
A61L
C02F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 March 2001	Thornton, S

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 12 6723

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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20-03-2001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4520793 A	04-06-1985	NONE	
GB 2040436 A	28-08-1980	DE 3001560 A	31-07-1980
		ES 487787 D	01-11-1980
		ES 8100201 A	16-01-1981
		FR 2446998 A	14-08-1980
		IT 1129526 B	04-06-1986

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

placed in the following manner: 1) in a three-sided cardboard box (nonreflective); a three-sided cardboard box lined with aluminum foil (reflective); 3) unprotected on the flat surface of the roof (unprotected); or 4) shielded from the sun (control). In order to evaluate the potential effects of oxidation, a fifth sample was treated by the addition of β-carotene and placed within a reflective box.

[0067] During a 6 hour exposure, viable *E. coli* counts declined almost 7.0 logs when the reflective pouch was placed within a reflective box to shield it from the cooling effects of wind and to further intensify light exposure (see Figure 10). Comparable effects were obtained with the reflective pouch was placed on the flat surface of the roof without added protection and reflective capacity. These results simplify the design of the solar disinfection system that could ultimately be employed as no additional packaging material or concepts need be incorporated.

[0068] It is interesting to note that shielding the plastic pouch in a cardboard box actually reduced the efficiency of disinfection by almost 3.0 logs. This is most likely due to the absorption of scattered light that would otherwise have reached the pouch. Lastly, the addition of β-carotene reduced the effectiveness of the solar disinfection system by almost 6.0 logs. These results could be accounted for by the antioxidative activity (quenching effect) of β-carotene or more simply by the absorbing capacity of the material in water. Additional experiments would be required to evaluate these alternatives.

[0069] Taken together, these results show that when a clean water supply is inoculated with pathogenic strains these can be significantly reduced using a freely available resource (sunlight) and a specifically designed plastic pouch constructed of materials carefully selected to transmit and amplify solar radiation. Since the system was functional during the cool weather of New England (Connecticut) at a time of declining total sunlight (Fall), it is highly likely that the system will function at least as well, if not better, in climates of higher average available sunlight. These are the developing regions where water quality is consistently poor, and the risk to infant health greatest.

[0070] The applications for such a solar disinfection system could include treatment when other options (resources) are not readily available, for example, disaster relief where widespread destruction of water treatment facilities has taken place (such as following Hurricanes or Earthquakes), and even potential military applications (individual water treatment during deployment).

[0071] It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications can be made without departing from the spirit and scope of the present invention and without diminishing its attended advantages. It is therefore intended that such changes and modifications be covered by the appended claims.

Claims

1. A container for use in reducing microbial contamination in water comprising:

   a body having a first and a second side and defining an interior for receiving a fluid;
   the first side being defined, at least in part, by a UV transparent layer; and
   the second side being defined, at least in part, by a second layer that amplifies the effect of solar energy that passes through the first side.

2. The container of Claim I wherein the container includes a member for receiving the fluid.

3. The container of Claim 2 wherein the member is a resealable fitment.

4. The container of Claim 1 wherein the second layer is constructed from a reflective plastic.

5. The container of Claim 1 wherein the second layer is constructed from a metalized reflective plastic.

6. The container of Claim 1 wherein the second layer is constructed from a material that absorbs solar radiation.

7. The container of Claim 1 wherein the second layer has a black surface.

8. The container of Claim 1 wherein the second layer is not transparent to UV light.

9. The container of Claim 1 wherein the body is made of a flexible plastic.

10. A method for reducing the bacteria contaminants in water comprising the steps of:

    providing a container including a body having a first side and a second side and defining an interior therein, the first side being defined, at least in part, by a UV transparent layer and the second layer being defined, at least in part, by a layer that amplifies the effect of UV light that passes through the first side;
    placing water in the container; and
    exposing the container to sunlight.

11. The method of Claim 10 wherein the second layer generates heat in response to UV light.

12. The method of Claim 10 wherein the second layer reflects UV light that passes through the first layer.

13. The method of Claim 10 wherein the container is

1517449 COMPLETE SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

FIG 1

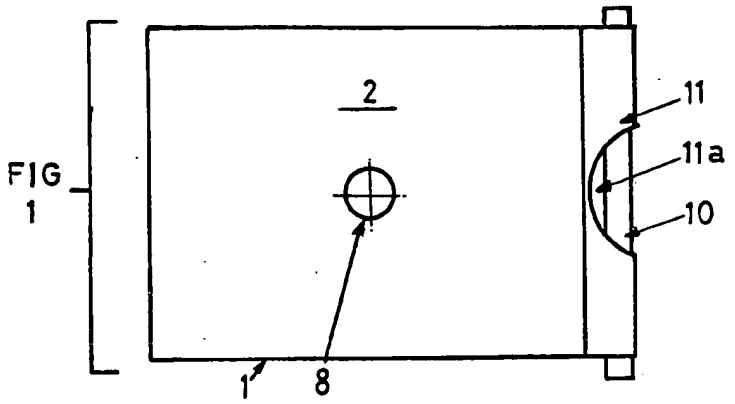


FIG 3

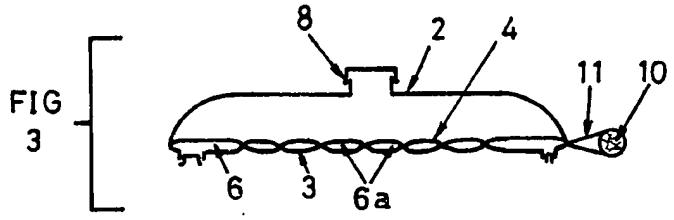
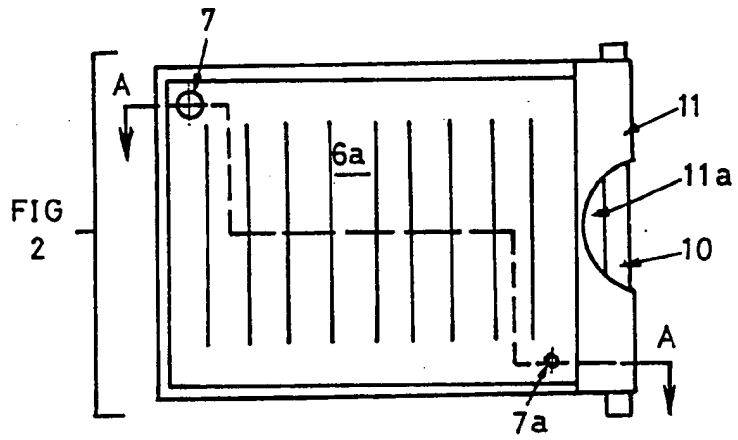


FIG 2



1517449 COMPLETE SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

FIG 7

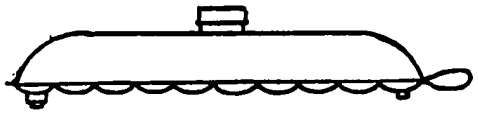


FIG 6

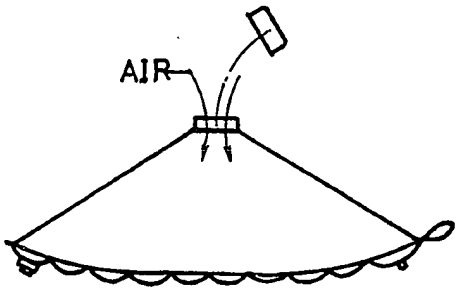


FIG 5

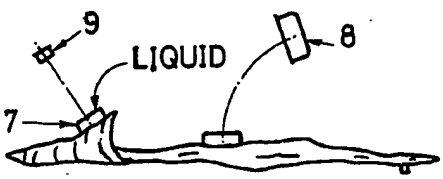
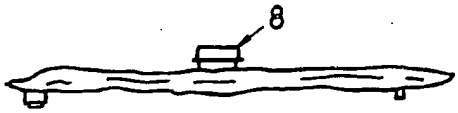


FIG 4



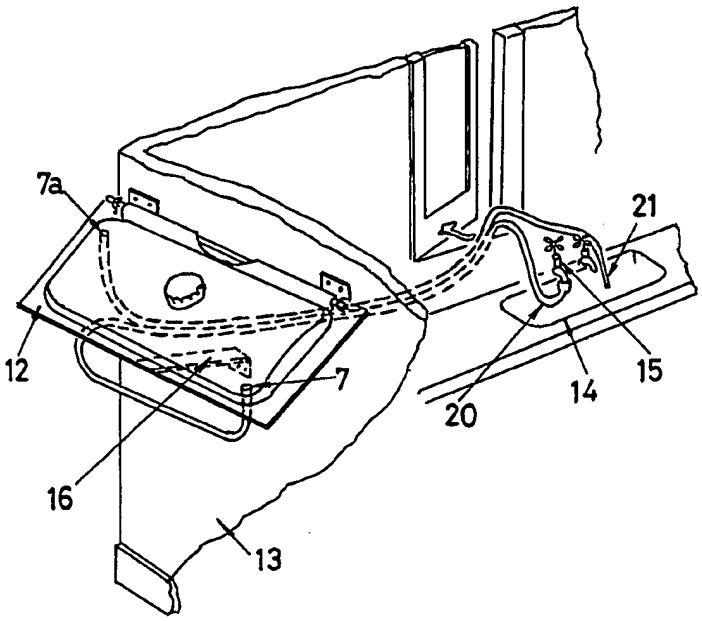


FIG. 8

PATENT SPECIFICATION (11) 1 517 449

1 517 449

(21) Application No. 35910/76 (22) Filed 28 Aug. 1976
(23) Complete Specification Filed 27 Oct. 1977
(44) Complete Specification published 12 July 1978
(51) INT CL² F24J 3/02
(52) Index at acceptance
F4U 60

(19)

(54) "SOLAR ENERGY HEATER"

(71) I, DAMASIUS BENETTE IAN WICKRAMASURIYA, of 25 Vicarage Hill, South Benfleet, Essex, a subject of Sri Lanka,

do hereby declare the invention, for which I pray that a Patent may be granted to me, and the method by which it is to be performed, to be described in and by the following statement:

The present invention relates to a device for heating liquids by means of solar energy, and hereinafter referred to as a solar energy heater.

Many forms of solar energy heaters are known in which solar heat is utilised to raise the temperature of a fluid, usually a liquid such as water. Many such heaters are bulky and cumbersome and require precise installation and location on site and are therefore not conveniently portable.

It is an object of the present invention to provide an easily portable solar energy heater of particular use in camping or domestic applications.

Accordingly the present invention is a solar energy heater for liquids comprising a flexible envelope formed of a first outer sheet of opaque material intended to rest on a support surface and a second outer sheet of transparent material intended to be exposed to solar radiation, said sheets being sealingly separated by a third sheet made of dark coloured thermally absorbtive material which constitutes a single common wall between a container for liquid which is also bounded by said first sheet, and a container for air which is also bounded by said second sheet, said liquid and air containers each having a closable opening to permit entry and exit of liquid and air respectively when required.

The envelope may be conveniently fabricated from plastic resin sheet materials such as a polyolefine, polyacrylate, polystyrene or P.V.C. Preferably, the sheet materials employed are flexible and the use of P.V.C. is especially preferred for fabrication of the sheet materials. The first lower sheet material is preferably coloured black e.g. a black P.V.C. sheet. The third sheet material is dark coloured e.g. black.

The envelope may suitably be formed from the sheet materials by sandwiching the sheets together and sealed together at their periphery by means of adhesive or welding. In an embodiment the lower liquid tight container may be constructed as a labyrinth by means of adhesive, or preferably heat sealing, to form a plurality of open compartments communicating with the inlet/outlet means.

The inlet/outlet means in the gas-tight chamber may comprise a single port provided with a suitable gas-tight closure. The inlet/outlet means in the liquid-tight chamber may comprise a single or plurality of ports provided with suitable liquid tight closures. In that embodiment wherein the liquid-tight chamber is constructed as a labyrinth inlet/outlet ports may be provided one at each end of the convoluted passageway.

The present invention is described further with reference to the accompanying drawings of a preferred embodiment and modifications thereof.

In these drawings:

Figure 1 is a plan view of a solar energy heater;

Figure 2 is an inverted plan view;

Figure 3 is a section on line A-A of Figure 2;

Figures 4 to 7 illustrate successive stages of inflation of the heater; and

Figure 8 illustrates one mode of installation.

Referring firstly to Figures 1, 2 and 3 the heater comprises an envelope 1 made of flexible P.V.C. and formed of an upper transparent sheet 2 and a lower opaque sheet 3 which is preferably coloured black.

A third sheet 4 of a dark colour, preferably black, to discourage algae is heat sealed around its periphery to the peripheries of the upper and lower sheets 2,3 so as to form an upper gas-tight container 5 when a central opening in the sheet 2 is closed by a cap 8. The sheet 4 is also additionally heat sealed to the lower sheet 3 to form a liquid-tight container 6 having a series of open compartments 6*a*. The container 6 has at one corner a main opening 7 for the inlet and outlet of liquid to be heated, and at the opposite corner an auxiliary opening 7*a* for a purpose hereinafter mentioned. Each of these openings is closable by means of a cap 9.

It is also preferred that the lower sheet 4 should be a 2-ply laminate comprised of a heat insulating base layer, and an upper membrane of material with a top reflective surface. The envelope has a pocket 11 at one end which accommodates a carrying handle 10 accessible centrally where the pocket has a recess 11*a*.

To prepare the solar heater for operation, a procedure explained with reference to Figures 4 to 7 is followed. Figure 4 shows the envelope totally collapsed for purposes of storage. Firstly, as illustrated in Figure 5, the caps 8 and 9 are removed from the envelope and liquid to be heated, e.g. water, is poured into the container 6 through the opening 7 until this container is filled, the cap 9 being then replaced.

Secondly (Figure 6) the top of the envelope is lifted from the centre so as to cause ingress of air to the top container 2; the cap 8 is then replaced and the envelope is released whereupon it has the appearance shown in Figure 7. Alternatively an air pump could be used to inflate the container 2.

The heater is then exposed to the heat of the sun and, after a suitable period of time, the water or other liquid heated by the solar energy is removed through one of the openings 7, 7*a*. The heated water may be used for any desired purpose e.g. as domestic water for cleaning or central heating purposes or for use in swimming pools. If suitable non-toxic materials are used to form the lower container 6 the water could be used for drinking.

EXAMPLE

In a specific example of the use of a solar heater as described above, the envelope 1 of size 6′ x 3′ with a liquid volume in the lower container of 2 gallons, was filled with water in the lower container at a temperature of 21°C. After exposure to solar energy for 50 minutes the water temperature had risen to 58°/59°C.

In a similar experiment water introduced at 16°C. was heated to a temperature of 34°/35°C. after a period of 30 minutes.

The solar energy heating device as above described is portable and the air container is readily inflatable.

The advantages of the separate compartments 6*a* in the liquid-tight container 6 are two fold.

Firstly compartments 6*a* impart stability of shape to the heater by ensuring that the liquid container 6 is of uniform thickness whether it is placed on a flat or on a sloping support surface, a feature which is of advantage when required to be used on camp sites and so forth.

Secondly the compartments serve to hold the designed volume of liquid in the liquid container and to spread it as a relatively flat layer throughout the container whilst also preventing accidental over-filling of the liquid container which would cause the latter to have a non-uniform depth between opposite side edges.

Figure 8 shows a mode of domestic use or installation of the heater. The heater is thus mounted on a platform 12 which is hingedly attached to the wall 13 of a house adjacent a room with a sink 14 and cold water tap 15. The platform is supportable by a stay 16 and the openings 7 and 7*a* are coupled respectively to a pipe 20 connected to the tap 15 and to a heated water pipe 21.

WHAT I CLAIM IS:

1. A solar energy heater for liquids comprising a flexible envelope formed of a first outer sheet of opaque material intended to rest on a support surface and a second outer sheet of transparent material intended to be exposed to solar radiation, said sheets being sealingly separated by a third sheet made of dark coloured thermally absorbtive material which constitutes a single common wall between a container for liquid which is also bounded by said first sheet, and a container for air which is also bounded by said second sheet, said liquid and air containers each having a closable opening to permit entry and exit of liquid and air respectively when required.

2. A solar energy heater as claimed in claim 1 in which the liquid container has a plurality of open compartments. Communicating with the closable opening.

3. A solar energy heater as claimed in claim 1 or claim 2 wherein there is an opening in said air container which is disposed substantially centrally in said second sheet, for permitting inflation of said air container as described with reference to Figures 4 to 7 of the accompanying drawings.

4. A solar energy heater as claimed in claim 1, 2 or 3 wherein the liquid container has two openings respectively at opposite corners thereof.

5. A solar energy heater as claimed in any of claims 1 to 4 in which the envelope is provided with a pocket which accommodates a carrying handle.

6. A solar energy heater as claimed in

claim 1 substantially as hereinbefore described with reference to Figures 1 to 3 of the accompanying drawings.

7. A solar energy heater as claimed in claim 1 when installed substantially as hereinbefore described with reference to Figure 8 of the accompanying drawing.

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